

Tomography of a Macroporous Silica Particle using the X1A Cryo STXM¹

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Beamline(s): X1A

Soft x-ray microtomography fills a niche in 3D imaging². Its spatial resolution is between that of visible light microscopy and transmission electron microscopy. Its spectroscopic capability is an enhancement over either of these techniques. The X-ray absorption length (0.93 μm for silica particles at 520 eV) in a variety of materials permits the imaging of specimens up to $\sim 2 \mu\text{m}$ thick with reasonable contrast. The large depth of field for zone plate optics with respect to the transverse resolution motivates the development of parallel beam tomography on our Cryo STXM³.

Using recent improvements to the microscope⁴, we have acquired a tilt series of a macroporous silica particle. This material provides a high surface area for catalysts. The goal has been to map the macroporous structure, where pores have a size range of 100-700 nm. This necessitated an image pixel step size (20 nm) that pushed the limits of spatial resolution for the optics to $\delta_i=184 \text{ nm}$ (the theoretical limit is $\delta_i=55 \text{ nm}$).

Projections were acquired at 5° intervals about a single axis over an experimental-setup-limited 75° range. To reconstruct the projection optical densities into mean voxel absorption lengths, the algebraic reconstruction technique (ART) was used because of its effectiveness with large tilt intervals and limited angular range. Given a total measured optical density per projection, the number of voxels in the reconstruction, which should be occupied by silica, can be estimated, providing us with a crude thresholding technique. One projection and several thresholded sections at various depths are displayed below.

References: ¹ J. Maser, A. Osanna, Y. Wang, C. Jacobsen, J. Kirz, S. Spector, B. Winn and D. Tennant, "Soft x-ray microscopy with a cryo STXM: I. Instrumentation," *Journal of Microscopy*, **197**, 68, 2000. ² W. Haddad, I. McNulty, J. Trebes, E. Anderson, R. Levesque and L. Yang, "Ultra high resolution x-ray tomography," *Science*, **266**, 1213, 1994. ³ Y. Wang, C. Jacobsen, J. Maser and A. Osanna, "Soft x-ray microscopy with a cryo STXM: II. Tomography", *Journal of Microscopy*, **197**, 80, 2000. ⁴ B. Winn, "Tomography with a Cryogenic Scanning Transmission X-ray Microscope," Ph.D. Thesis, SUNY Stony Brook, NY, USA, 2000.

